

The Biology of *Plebejus (Icaricia) shasta* in the Western United States (Lycaenidae)

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Abstract: 1. The habitat, foodplants, and life history of *Plebejus (Icaricia) shasta* are described, based on field observations of a number of populations in the western United States. 2. 13 foodplant species are recorded for *P. shasta*; four genera are represented and all are in the family Fabaceae.

Introduction

We report here the results of our field studies and museum research on *Plebejus (Icaricia) shasta* (Edwards) over a ten year period. This species first engaged our interest during the summer of 1967 when we made several observations on its habitats and foodplants. Following this, we did extensive field work in 1968, 1969, and 1970. From 1971 to 1977, we gathered records from various individuals and institutions and did further field studies, to help determine distribution, flight period, and patterns of geographic variation.

Taxonomy and Distribution

Ferris (1976) revised the taxonomy of *P. shasta* and concluded that three subspecific names were sufficient to apply to all known populations. The California and Oregon populations fell under nominate *shasta*, *pitkinensis* Ferris referred to arctic-alpine populations in Colorado, and *minnehaha* Scudder was used for the remaining populations from the Great Basin to the western prairie region. *P. s. comstocki* Fox was sunk as a synonym of nominate *shasta*, and *P. s. browni* Ferris was relegated to synonymy under *minnehaha*.

Although we are in general agreement with most of Ferris's concept of the subspeciation of *P. shasta*, we would make several changes in this scheme. We see the name *minnehaha* serving primarily as a "waste-basket" category for a rather diverse array of geographically isolated populations, to be used only until more detailed studies can be made. Numerical taxonomy may prove to be the best means of sorting these out. Also, phenotypically and biologically, certain populations that Ferris included with nominate *shasta* seem to have a closer affinity with the Great Basin populations. These are the Oregon

populations and the California populations in the White Mountains (Inyo and Mono counties) and in Modoc and Lassen counties; these we would temporarily "lump" with *minnehaha*. We have not personally examined specimens from the Mt. Shasta region and cannot comment on their affinities.

The Wyoming specimens from the slopes of Medicine Bow Peak, 11,500', Carbon Co., are included with *minnehaha* by Ferris. Biologically and phenotypically, we feel that these are much closer to *pitkinensis*. The single female of this population that we have examined shows the slate-blue-gray upperside typical of the Colorado specimens of *pitkinensis*.

Specimens from the Spring Range, Clark County, Nevada, are particularly distinctive from the three described subspecies; this new subspecies is being intensively studied by George Austin of Las Vegas, Nevada. He will publish the results of his studies in a future paper.

We agree with Ferris that records for *shasta* from Alaska, British Columbia, and Washington are highly questionable and need confirmation before the species can be stated to exist in these regions. A single male in the Los Angeles County Museum labelled "Tehachapi Mts., Kern Co., Calif", is also doubtful as no other specimens are known from that relatively well-collected mountain range.

Habitat

Although *P. shasta* is found over a wide altitudinal range (1,200 to 13,000 feet elevation), its immediate habitat exhibits a number of common features. Typically, it occurs on open, exposed, sunny, gravelly-soiled and well-drained flats, slopes, hilltops, or ridges. These areas are often free of winter snow relatively early in the spring. Although the winter snowfall may be substantial (as at Donner Pass, California), by the time *P. shasta* adults are in flight, the ground is usually quite dry due to the combination of good drainage and early snowmelt from a favorable slope exposure.

At most elevations below approximately 11,500', the associated plant community is Sagebrush Scrub (Munz, 1959). At the highest elevations, the species flies over arctic-alpine fell-fields. Regardless of elevation, the associated vegetation is usually scrubby, low-growing, and relatively sparse. Some of the plants in *P. shasta* habitats in the Sierra Nevada are prostrate *Eriogonum* species, *Castilleja nana* Eastw., *Penstemon heterodoxus* Gray, and *Erigeron pygmaeus* (Gray) Greene. In the Great Basin ranges, some of the most commonly

associated plants are *Artemisia tridentata* Nutt., dwarf *Castilleja* species, and *Pinus aristata* Engelm. In the Rocky Mountain region, Ferris (1976) notes the associated plants to be *Sedum* species and *Eriogonum* species in addition to sagebrush.

Foodplants

We recorded 13 species of Fabaceae as foodplants for *P. shasta*. These plants are listed in the Table, and are documented in the Appendix in accordance with a method we have previously described and used (Shields et al, 1969).

Although four genera are represented, all foodplants, with one exception, have a remarkably similar growth habit. They are perennials with long taproots, growing in a prostrate manner or forming mats on the ground. This is an adaptation to the exposed areas where these plants grow, where high winds are frequent and occasional heavy winter snows produce an enormous weight on the underlying vegetation.

The majority of plants used are in the genus *Astragalus*. This is a very large genus within the territory covered by the range of *P. shasta*, with over 100 species represented (Barneby, 1964). Undoubtedly more foodplants in this genus will be recorded in future field work. We record one species of *Oxytropis*, a genus very closely related to *Astragalus*. The three *Trifolium* species used by *P. shasta* are adapted to dry, exposed slopes, unlike many members of this genus which prefer moist meadows.

Of the three *Lupinus* species we recorded, two are mat-formers while the third, *L. arbustus*, grows as a small herbaceous bush. We suspect that *L. arbustus* is not a regularly used host, and that this plant and certain other fabaceous species may be used occasionally if they are growing in close proximity to commonly used *shasta* foodplants. In the case of *L. arbustus*, we searched numerous individuals of this species but found only a single larva of *P. shasta* feeding on it. On nearby plants of *Astragalus whitneyi*, *shasta* larvae were relatively easy to locate. Similarly, when we observed ovipositing females in this same locality (Donner Pass) at a later date, *Astragalus* was repeatedly visited while *L. arbustus* was ignored. In view of the large number of plant species used by *shasta*, and hence a relatively broad variety of biochemical stimuli tolerated by ovipositing females, it is not surprising that non-prostrate fabaceous species are sometimes used. This suggests that ovipositing females are responding to the visual stimulus of a prostrate growth habit in addition to biochemical stimuli.

Life History

The females we observed would hover about and land repeatedly on the foodplant, and then walk over the plant for several seconds to minutes before ovipositing. Oviposition did not take place on any particular part of the plant. Ova were placed on leaf surfaces, petioles, stems, and seed pods. Occasionally, an ovum would be deposited on ground litter near the base of the plant. We found a number of hatched eggshells adjacent to newly laid eggs, indicating that the ova do not overwinter. Diapause is likely passed as a partly-grown larva, similar to *Plebejus icarioides* (Boisd.) (Comstock & Dammers, 1935).

Soon after snowmelt in mid-June, we found nearly mature, post-diapause larvae at two localities in the Sierra Nevada. These larvae were found feeding on the flowers and young leaves of the foodplant, or else resting in ground litter near the bases of the plants. Unfortunately, due to other pressing matters at the time that the larvae were collected, we were unable to make detailed notes on larval morphology and coloration. A photograph of one of these larvae by Edward Ross is shown in Figure 1. The ground color of the mature larva is a dirty white or cream with prominent dark brown chevrons when viewed dorsally.

Pupation probably takes place in ground litter near the caudex of the foodplant. In the rearing jars, pupation took place under foodplant litter at the bottoms of the containers. Emergence of adults occurred about two weeks after pupation, always in the early morning hours. Pupal morphology is similar to that of *Plebejus (Icaricia) acmon* (Westw. & Hew.) and *P. (I.) icarioides* (see Comstock & Dammers, 1935). The wing cases are pale green, with the body light tan to pale greenish-tan.

Four species of ants were noted to "tend" the post-diapause larvae. At Donner Pass, Placer Co., Calif., *Formica fusca* Linne and *F. neogagates* Em. were the associated ants. Both *Formica densiventris* Vier. and *F. oreas* Whlr. were observed to tend larvae at Ebbetts Pass, Alpine Co., Calif.

Flight Period

Most adults have been taken during the months of July and August, although June captures are not uncommon at the lower elevations. Date of emergence depends on a number of factors, including elevation, snowpack, slope exposure, and time of snowmelt. Considerable spread is possible in a given locality due to local variations in exposure and time of snowmelt. The earliest record we have is June 9

at 5100 feet elevation in Wyoming. The latest record is September 6 at 12,000 feet elevation in California.

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We also thank Edward S. Ross, California Academy of Sciences, for photographing the larva. Roy Snelling of the Los Angeles County Museum of Natural History made the ant identifications. Dennis E. Breedlove, California Academy of Sciences, identified most of the plant specimens collected from 1967 to 1971. Robert F. Thorne and Richard Tilforth of the Rancho Santa Ana Botanic Garden also made plant identifications. Clifford Ferris sent specimens of *P. shasta* from Wyoming, and provided helpful suggestions and information.

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Appendix

Collection and Foodplant Records

In the following list of records, collectors' names are given in parentheses. Collection of deposition is that of the collector(s) unless otherwise designated by the initials of another collector or institution (see Acknowledgements for key to initials). Foodplant records are reported in accordance with a method we have previously described (Shields et al, 1969). All foodplant records are observations by the authors unless otherwise noted.

P. shasta shasta

CALIFORNIA. *Alpine Co.*: Carson Pass, rocky ridge, VII-6-61, "1" (N. La Due); Carson Pass, Winnemucca Lake, 9000', VIII-24-64, 1♂ 1♀ (D.L. Bauer); Carson Pass, slope of Red Lake Pk., 9000', VIII-17-64, 1♀ (D.L. Bauer); ridgetop E. of Hwy. 88 at Carson Spur, 8000-9000', VII-18-71, 5♂ 1♀ (R. Wells); Ebbetts Pass, 8730', VIII-7-69, open gravelly hilltop, ♀ oviposited at 11:20 PST on underside of leaflet, another at 11:30 PST on upperside of leaflet of *Astragalus purshii* Dougl. (J.F. Emmel #211, CAS); Ebbetts Pass, on slope 0.2 air mile SSE of Ebbetts Peak, 8750', VI-17-70, open gravelly slope, 12 larvae, 4th-5th instar, at base of plants or feeding on flowers of *Astragalus purshii* Dougl. (J.F. Emmel #306, CAS); Ebbetts Pass, 8700-9100', VII-18-54, 2♂ (P. Opler); VI-30-60, 1♀ (J. Powell, CIS); VII-26-65 (D. L. Bauer); VIII-1-70, 7♂ (R. Wells); VIII-8-71, "3" (J. Mori & O. Shields); NW above Ebbetts Pass, VII-20-72, "1" (R. F. Denno, R. Rust, O. Shields); Monitor Pass, 8300', VII-16-72, 3♂ 1♀ (R. Wells); VII-23-64 (D. L. Bauer); 1.4 mi. N. Monitor Pass, Hwy. 89, 7950', VII-2-74, 1♀ (E. M. Perkins & O. Shields). *Amador Co.*: Carson Spur, nr. Silver Lake, VII-18-57, 8♂; VIII-5-57, 1♂ 1♀; VII-18-58, 10♂; VII-24-58, 2♂ 4♀; VI-30-59, 3♂ 1♀; VII-8-59, 1♂ 1♀; VI-27 & 28-60, 29♂ 2♀; VII-6-61, 1♂ (all N. La Due); Carson Spur, VII-18-71, 5♂ (J. Brock); Silver Lake, VII-20-41, 1♂ (UCD); Tragedy Springs, 8000', just W. of Silver Lake on old Hwy. 88, VII-6-61, 2♂ (N. La Due). *El Dorado Co.*: Job's Sister Pk., 9000', SE end Lake Tahoe, VIII-4-63 (D. L. Bauer); trail between SW end Fallen Leaf Lake and summit Mt. Tallac, 6300-9700', VIII-28-76, "1" (O. Shields & S. Sims). *Fresno Co.*: Kaiser Crest, VII-21-73 (In: News Lepid. Soc. 1974, No. 2, 19 pp., Season Summary for 1973); Mono Pass, IX-6-47, 1♀ (C. D. MacNeill, CIS). *Fresno-Inyo Co. line*: Piute Pass, 11,400', VIII-11-63, 1♂ (O. Shields). *Kern Co.*: Tehachapi Mts., VIII-22-37, 1♂ ("pres. by W. A. Evans collector", LACM). *Mariposa Co.*: Boundary Hill, Research Reserve Area, Yosemite Nat'l Park, VII-20-70, 1♀ (R. P. Allen, UCD). *Mono Co.*: Carnegie Exp. Gardens, 10,000', Slate Creek Valley, VIII-8- to 13-64, "a few" (O. Shields); W. end of Dana Plateau, 11,000', above Tioga Pass, VIII-8-69, open gravelly ground, ♀ oviposited at 2:20 PST on leaf near base of *Lupinus lyallii* Gray (J. F. Emmel # 215, CAS); just over E. side of Donahue Pass, VIII-4 to 6-59, "common, 50 taken" (O. Shields); trail to Upper Gaylor Lake, Tioga Pass, VIII-26-56, 3♂ 2♀ (R. Langston); VII-9-61, 1♂; VII-30-61, 3♂ (both S. Mattoon); Glacier Canyon, ca 11,000-11,300', N. slope Mt. Dana, VII-4-64, 2♂ (O. Shields); Leavitt Peak, 11,000', Sonora Pass, VIII-9-64, 1♀ (D. L. Bauer); Mammoth Crest, VII-18 & 21-52, 4♂ 1♀ (J. Powell, CIS); Mammoth Rock, VII-29-52, 12♂ 6♀ (J. Powell & M. J. McKenney, CIS); Minaret Vista (ridge), Hwy. 203, W. of Mammoth Mtn, 9265', VII-6-74, 3♂ (E. Perkins & O. Shields); 1.2 air miles S. of Bodie, Bodie Hills, 8480', VII-26-74, several females showed pre-oviposition behavior toward *Lupinus breweri* Gray var. *bryoides* C. P. Sm. in Jeps. (J. F. Emmel #526, RSABG); Mt. Dana, VIII-16-53, 4♂ (n. La Due); Saddlebag Lake, VII-21-54, 1♂ (J. Powell, CIS); Tioga Crest, VI-21-52, 1♀ (J. Powell, CIS); Tioga Pass, 9900-10,000', VII-14-58, 4♂; VII-30-64, 3♂ 4♀; VII-24-66, "8"; VII-26-72, 1♂ 3♀ (all O. Shields); NW above Tioga Pass, VIII-22-65, 1♂ 2♀ (O. Shields); W. above Tioga Pass, VIII-3-58, 1♂ (N. La Due); VIII-20-58, 2♂ 2♀; VIII-10-63, 5♂ (both O. Shields). *Nevada Co.*: Sagehen Crk., VII-15-66, 1♂ (UCD). *Placer Co.*: N. slope of Donner Peak, 7600', VII-25-68, on exposed dry gravelly slope, 3♀ observed to

oviposit on plants, mainly on leaves, of *Astragalus whitneyi* Gray (J. F. Emmel #100, DHSU); slope between Donner Peak & Donner Pass, 7400', VI-15-69, on open gravelly slope, six 5th instar larvae feeding on leaves and flowers, some hiding at base of plant, of *Astragalus whitneyi* Gray (J. F. Emmel #167, CAS); N. slope of Mt. Judah, VII-6-63, 2♂ 3♀; VIII-21-67, 1♂ 1♀ (both N. La Due); north peak of Mt. Judah, 8100-8200', S. above Donner Pass, VI-15-69, on open gravelly slope, one 5th instar larva in litter at base of *Lupinus arbustus* Dougl. (J. F. Emmel #168, CAS) (larva reared to pupa on same plant). Siskiyou Co.: Methodist Camp Meadow, Castle Lake (S. Mattoon); W. slope Mt. Eddy, SW of Weed, VII-1-74, "large series" (S. Mattoon). Tulare Co.: Shepherd Pass trail, divide between Wright Lakes & Tyndall Creek, 11,200-12,200', VII-27-66 (S. Ellis & S. Johnson). Tuolumne Co.: above Upper Gaylor Lake, 11,200', VIII-3-68, on open rocky slope, 2♀ oviposited on stem and leaf underside of *Lupinus lyallii* Gray (J. F. Emmel #104, DHSU); Blue Canyon, Sonora Pass, VIII-30-60, 1♀ (J. Powell, CIS); meadows & slopes by Helen Lake, S. of Tioga Pass, VII-18-58, 5♂ (O. Shields); Lunch Mdw., nr. Emigrant Basin, VIII-15-54, 1♂ 1♀ (P. Opler); N. of Sonora Pass, VII-5-59, 1♂ (N. La Due); Sonora Peak, VIII-10-57, 1♀ (J. Powell, CIS); above Upper Gaylor Lake, ca. 11,000', VI-19-58, 2♂ (O. Shields). Tuolumne-Mono Co. line: Sonora Pass, VII-8-61, 2♂ (S. Mattoon); VIII-1-52, 1♂ 1♀; VIII-5-58, 2♂; VII-7-59, 2♂ (all N. La Due); VII-3-59, 5♂ 2♀; VII-18-59, 4♂; VII-2-66, 1♂ 1♀ (all P. Opler); VIII-21-59, 2♂ (J. Powell, CIS); VII-31-64, 4♂ 1♀ (O. Shields); VII-9-64, 1♂ 1♀; VIII-9-67 (both D. Bauer); VIII-7-71, "7" (J. Mori & O. Shields); IX-5-71, 3♂ 2♀ (R. Wells); VIII-12-73, 2♂ (S. Sims).

NEVADA. Ormsby Co.: Snow Valley Pk., 9274', Carson Range, VII-27-64, 1♂ 1♀ (D. Bauer). Washoe Co.: Lake Tahoe (Glen Alpine & Mt. Rose area), VII-26-50, 1♂ 1♀ (D. Bauer); Mt. Rose summit, 8500', Carson Range, VII-29-64, 1♂ (D. Bauer); Tamarack Lake, Mt. Rose, VII-29-64 (D. Bauer).

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CANADA: ALBERTA. Red Deer River, Gleichen, VII-1, 5, 6-05, 2♂ 1♀ (F. Wolley Dod, LACM).

UNITED STATES. CALIFORNIA. Inyo Co.: Bristlecone Pine Nat. Mon. at Hdq., VII-22-68, 2♂ (R. Wells); 0.5 air mile SE of Goat Spring, 4 mi. S. of County Line Hill, White Mts., 10,400', VII-6-68, on open gravelly ground. 3 ova on plants, underside of leaf and on stem, and ♀ oviposition behavior toward these plants, on *Astragalus kentrophyta* Gray var. *implexus* (Canby) Barneby (J.F. Emmel #111, DHSU); same locality & date, ♀ oviposited on leaf underside of *Trifolium monoense* Greene (J. F. Emmel #110, DHSU); White Mts., VIII-3-72, "common" (J. Brock & R. Wells). Lassen Co.: Susan River nr. Bridge Creek Camp, VII-8-49, 1♂ (R. Langston); 5 mi. N. Westwood, VII-2-61, 1♂ (O. Shields). Modoc Co.: NW slope of Mt. Bidwell, 7900', Warner Mts., VII-16-68, on open ground, sagebrush, several ♀ showed pre-oviposition behavior toward *Astragalus purshii* Dougl. (J.F. Emmel #84, DHSU). Mono Co.: Crooked Creek Lab., 10,150', White Mts., 3 air mi. N. of Inyo Co. line, VI-26-61, 3♂ 1♀ (J. Powell, CIS: S. Buckett, UCD); VII-20-61, 5♂ 3♀ (J. Powell, CIS); Mt. Bancroft, 12,500', White Mts., VII-11-61, 1♂ (J. S. Buckett, UCD); Mt. Barcroft Lab., 12,500', White Mts., 9 air mi. N. Inyo Co. line, VII-21-61,

1♀ (J. Powell, CIS); Sheep Mt., 11,200', White Mts., VII-6-61, 4♂ 3♀ (J. Powell, CIS).

COLORADO. *Moffat Co.*: nr. Diamond Peak, 9200', VII-8-72 (J. Scott).

IDAHO. *Bear Lake Co.*: M-Hill, Montpelier, VII-14-29, 2♂ (W. J. Gertsch, BYU).

Lemhi Co.: N. side of Gunsight Peak, 9200', Lemhi Range, VII-31-72 (S. Ellis & L. Thompson).

MONTANA. *Fergus Co.*: 2 mi. S. of summit on Heath-Slayton road, 6000', Big Snowy Mts., VI-15-69, 1♀ (J. Shepard). *Golden Valley Co.*: 8 mi. S. of summit of Heath-Slayton road, 4800', Big Snowy Mts., VI-15-69, 3♂ 1♀ (J. Shepard). *Meagher Co.*: Martindale, VI-18-00, 2♂ (C.J. Paine, MCZ).

NEBRASKA. *Sioux Co.*: canyon region N. of Harrison, VII-14-17, 1♂ 1♀ (R.A. Leussler, AMNH).

NEVADA. *Clark Co.*: Kyle Canyon, 8500-9000', VII-25 & 27-65 (A. Austin); Lee Canyon, 8250-8800', VII-21-63 (A. Austin); Willow Creek, 6000-8000', Charleston Range, VII-15-28-28, 15♂ 19♀ (J. Gunder, AMNH). *Douglas Co.*: Pine Nut Mts. (D. Bauer). *Elko Co.*: ridge 0.5 air mile due N. of Angel Lake, 8700', East Humboldt Range, VII-26-69, gravelly open area, ♀ oviposited at 1:30 PST on leaf upperside of *Astragalus calycosus* Torr. var. *mancus* (Rydb.) Barneby (*J.F. Emmel #197*, CAS); Angel Lake Cpgd., VII-16-73 "in numbers on gravelly ridges" (D. Eff, RL); peaks above Angel Lake, East Humboldt Range, VII-20-73, 2♂ (S. Sims); East Humboldt Range, high ridgecrests, VIII-5-71, "substantial series" (S. Mattoon); trail from Dollar Lake to Liberty Pass, S. end of Lamoille Cyn., 9600-10,450', Ruby Mts., VII-25-69, 7♂ 2♀ (J. Emmel & O. Shields); ridge ¾ air mile NW of Island Lake, 10,800-11,200', above Lamoille Cyn., Ruby Mts., VIII-8-67, 4♂ (J. Emmel, S. Ellis, O. Shields); slope 0.5 air mile S. of Bonanza Gulch, Jarbidge Mts., 8000-8500', VI-22-69, 27♂ 5♀ (J. Emmel & O. Shields); Bear Creek Summit, 8488', Jarbidge Mts., VII-24-69, 1♂ (J. Emmel & O. Shields); north slope of peak 2 air miles NE of Spruce Mtn. peak, 8800-9200', VII-28-69, 1♂ (J. Emmel & O. Shields). *Humboldt Co.*: summit of Buckskin Mtn., 8740', Santa Rosa Range, VIII-11-67, several females showed pre-oviposition behavior toward *Astragalus newberryi* Torr. (*J.F. Emmel #35*, DHSU); VII-20-69, 1♂ (J. Emmel & O. Shields); Hinkley Summit, 8000', Santa Rosa Mts., VII-14-64, 1♂ (D. Bauer); 14-16 mi. N. Paradise Valley, 7100-7867', VII-10-66, 1♂ 2♀ (F., P., & M. Rindge, AMNH); road to Blue Lake, ca. 8000', Pine Forest Range, VIII-1-71, 9♂ 30♀ (S. Mattoon); Sonoma Range, ridge between Water Cyn. & Thomas Cyn., 8000', VII-18-77, 1♀ (J. Emmel). *Lander Co.*: Bunker Hill, 11,400', Toiyabe Range, VIII-4-69, on gravelly slope near top of ridge, ♀ oviposited at 1:45 PST on underside of petiole of *Astragalus platytropis* Gray (*J.F. Emmel #208*, CAS); ridge to the WSW of Bunker Hill, 10,000-10,400', Toiyabe Range, VII-4-69, 5♂ 2♀ (J. Emmel & O. Shields); Bunker Hill and ridge to the SW, 11,000-11,474', Toiyabe Range, VII-4-69, 6♂ (J. Emmel & O. Shields); ridge 1.2 air miles NNE of highest peak of Bunker Hill, 10,000-10,400', Toiyabe Range, VIII-11-68, 1♂ (J. Emmel & O. Shields). *Mineral Co.*: Big Indian Mt., 10,000', Wassuk Range, VIII-3-64, 3♂ 4♀ (D. Bauer); Collins Canyon, 7800-9000', Wassuk Range, VIII-3-64, 1♂ (D. Bauer); Cory Peak, 10,500', VIII-3-64, 1♂ (D. Bauer). *Nye Co.*: toward upper end of Jett Canyon (3-4 mi. up canyon), Toiyabe Range, VII-9-71, 1♂ (O. Shields); E. side of alpine plateau of Mt.

Jefferson, 11,000', Toquima Range, VIII-4-67, ♀ oviposited on *Astragalus calycosus* Torr. (J.F. Emmel #28, DHSU); Pine Creek Cyn. Cpgd., 8100', E. side Toquima Range, VIII-4-67, 1♂ (J. Emmel, S. Ellis, O. Shields). *White Pine Co.*: Upper Lehman Creek, 14 mi. W. of Baker, 9800', VIII-4-66, 1♂ 1♀ (F., P., & M. Rindge, AMNH); Wheeler Peak, 10,000', VII-26-69, 5♂ 1♀ (C. Callaghan); trail from Wheeler Peak Campground to ridge above Stella Lake, 11,000', N. end of Snake Range, VII-30-69, on rocky ridgetop, gravelly soil, ♀ oviposited at 9:00 PST on leaf underside of *Trifolium gymnocarpum* Nutt. (J.F. Emmel #200, CAS); same locality & date, ♀ oviposited at 9:35 PST on underside of petiole of *Oxytropis parryi* A. Gray (J.F. Emmel #201, CAS); same locality, VIII-1-67, 1♂ (J. Emmel, O. Shields, S. Ellis)

OREGON. *Deschutes Co.*: Davis Lake, 4395', VII-22-34 (Dornfeld records); Little Cultus Lake & Cultus Creek, 4500', VII-4-63 (E.J. Newcomer); Pringle Falls, 4200', VII-23-60 (E.J. Newcomer); Snow Creek, 4600', VIII-4-63 (E.J. Newcomer). *Harney Co.*: Fish Lake, 7400', VIII-11-61 (E. J. Dornfeld); head of Little Blitzen Cr., 9300', VIII-8-64 (C. R. Crowe, Dornfeld records); Steens Mts., 9000', VIII-10-68 (E. J. Newcomer); Steens Mt. summit, 9500', VII-28-68 (C. W. Nelson, Dornfeld records); nr. summit of Steens Mts., 9500', VIII-13-67, 1♂ 1♀ (S. Mattoon); Steens Mts., ca. 7000', VII-25-36 (Dornfeld records). *Klamath Co.*: Beaver Marsh, VII-16-64, VII-16-64 6♂ 2♀ (J. Scott); ca. 5-10 mi. E. Beaver Marsh, ca. 4700', VI-14-61, 9♂ "on a lupine" (O. Shields); ca. 5 air mi. NE Chemult, along road to Walker Mtn. Lookout, Walker Rim, VII-9-70, 2♂ (S. Dvorak & O. Shields); 4 mi. SE of Crescent, ca. 4500', VII-15-61, 5♂ 1♀ (O. Shields); Diamond Lake, VII-14-33, 1♂ (UCD); Gilchrist, 4500', VIII-7-60, VII-28-62, VIII-14-63 (all E. J. Dornfeld); Skookum Meadow (Walker Rim), 5200', VI-23-61 (E. J. Newcomer). *Lake Co.*: Cannon Well, 5400', VII-30-61 (E. J. Newcomer); Drake Peak, 8000', VIII-3-63 (E. J. Newcomer); 3 mi. S. of Silver Lake, ca. 4800', VII-17-55 (R. J. Albright, Dornfeld records).

UTAH. *Box Elder Co.*: Clear Creek Canyon, 5600', Raft River Mts., VII-23 & 24-63, 1♂ 3♀; VII-13-66, 3♀ (both K. Tidwell); Holstein Ranger Station, 6500', VII-23-63, 2♀ (K. Tidwell). *Sanpete Co.*: 17 mi. E. Mayfield, 10,200', VIII-1-58, 1♂ (F., P., & J. Rindge, AMNH); Wasatch Plateau near Mt. Sanpete, 11,000', E. of Ephraim, VII-31-67, several females showed pre-oviposition behavior toward *Astragalus kentrophyta* Gray var. *elatus* Wats. (J.F. Emmel #26, DHSU); *Tooele Co.*: Deep Creek Mts., 9000', VII-24-67, 1♂ (C. Callaghan). *Uintah Co.*: Blue Mountain Plateau, vic. Relay Station, 7800', Dinosaur Nat. Mon., VI-22-68, 2♂ (S. Ellis); Dinosaur Nat. Mon., VI-18-66, 1♂ 3♀ (C. Callaghan); Iron Springs Camp, 25 mi. N. Vernal, 8700', VII-20-63, 1♀ (F., P., & M. Rindge, AMNH). *Wayne Co.*: Cathedral Valley Rd., 2.5 mi. E. of intersection with Elkhorn Campground Rd., 8400', VI-19-72 (S. Ellis & L. Thompson); Cathedral Valley Rd., 1 mi. E. of intersection with Elkhorn Cpgd. Rd., NE side of 1000 Lake Mtn., 8800', VI-19-72 (S. Ellis & L. Thompson).

WYOMING. *Albany Co.*: Telephone Creek, 8900', VII-18-62, 1♀ (J. K. Windsor, LACM); 2 mi. E. Laramie, 7200', VII-16 & 27-69 (C. D. Ferris, DG); Sybille Canyon, 2 mi. E. of Morton Pass on Wyo. Hwy. 34, 6700', VII-4, 10-11-66, VII-23-67, VII-12-69 (all D. Groothuis & R. Hardesty). *Carbon Co.*: N. of Riverside, 7000', VII-11-52, 2♂ 1♀ (V. Nabokov, MCZ). *Converse Co.*: ½ mile E. Douglas, 5100', VI-25-67, VII-9-67, VI-9, 17-69 (D. Groothuis & R. Hardesty); North Horseshoe

Creek, nr. Esterbrook, 6500', VII-9-67 (D. Groothuis & R. Hardesty). *Fremont Co.*: Dubois, 6500, VII-52, 2♂ 9♀ (V. Nabokov, MCZ). *Yellowstone National Park*: Sylvan Pass, VII-24-27, 2♂ (J. Comstock, LACM).

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COLORADO. *Boulder Co.*: Arapahoe Pass Trail, VII-6-53, 1♂, IX-1-47, 1♂ 1♀ (D. Eff, LACM); Niwot Ridge, VII-29-51, 1♂ 1♀ (D. Eff, LACM); Brainerd Lake, VII-27-47, 1♂ 1♀ (D. Eff, DB); Lefthand Park, VII-27-47, 1♂ 1♀ (D. Eff, DB). *Chaffee Co.*: Cottonwood Pass, VII-17-59, 1♂, VIII-8-61, 4♀ (R. Jae, NL, CC); Monarch Pass, VII-6-61 (J. Scott). *Clear Creek Co.*: Loveland Pass, VII-16-60; VII-28-72; VII-26-73 (all J. Scott). Mt. Evans, VII-7-60, 1♂ (LACM); Mt. Goliath, VIII-8-59, 2♂ 1♀ (R. Buchmiller, PO). *Clear Creek - Grand Co. line*: Berthoud Pass-Vasquez Peak, 11,314-12,927', VII-29-67, 14♂ 1♀ (F., P., & M. Rindge, AMNH). *Custer Co.*: Baldy Peak, 12,500', VII-29-70, 2♀ oviposited on *Trifolium dasyphyllum* T. & G. (J. Scott); Hermit Pass, 12,000-13,000', VII-23-70, VIII-1-71, oviposition on *Trifolium dasyphyllum* T. & G. (J. Scott); Rainbow Lake, VIII-13-67 (M. Howard, JS); Silver Lake, ca. 12,300', VIII-16-68 (J. Scott). *Fremont Co.*: Bear Creek above timberline, VII-28-70 (R. Taylor, JS); Hayden Pass, 10,700', VII-22-71 (J. Scott); Hunts Lake, VIII-5-70 (R. Taylor, JS); West Creek Lake, 12,000', VIII-11-70 (J. Scott). *Gilpin Co.*: S. of Tolland, VII-11-58, 1♂ (D. Eff, LACM); W. of Kingston, VIII-19-51, 2♂ (D. Eff, LACM); James Peak, VII-26-52, 1♂ 1♀ (AMNH). *Grand Co.*: Skyline Drive, near Kremmling, VII-6-69, 2♂ (D. Eff, LACM); Roger's Pass, VIII-17-62, 1♀ (D. Eff, LACM). *Gunnison Co.*: Cottonwood Pass, 12,000', VII-19-64 (S. Ellis); Cumberland Pass, 12,025', VII-17-62, 4♂ 2♀ (J. Shepard); Emerald Lake, VIII-8-61 (J. Scott); Monarch Pass, VIII-6-61, VII-29-67 (J. Scott). *Gunnison-Chaffee Co. line*: ridge summit, near radar towers, just E. of Monarch Pass, VIII-14-70, 10♂ (S. Ellis & O. Shields). *Hinsdale Co.*: E. Rio Grande Pyramid, VII-28-71 (J. Scott); Stony Pass, 15 mi. NW of Rio Grande Pyramid, 12,000', VII-20-68 (S. Ellis). *Larimer Co.*: Trail Ridge Rd., 12,300', VIII-24-71 (J. Scott). *Park Co.*: Buffalo Peaks, VIII-12-73 (J. Scott). *Pitkin Co.*: Independence Pass, VII-15-59, 1♂ (N. La Due). *Pueblo Co.*: Greenhorn Peak, ca. 12,000', VII-13-70 (J. Scott).

WYOMING. *Carbon Co.*: Medicine Bow Peak, Snowy Range, 11,500', VII-17-62, 2♂ 1♀ (J. K. Windsor, LACM).



Fig. 1. Last instar larva of *P. shasta*. Photo by E. S. Ross.

Table I

Foodplants of *P. shasta*. Key to observation abbreviations: O = female oviposited on plant, or ova found on plant; L = larvae found on plant; P = pre-oviposition behavior by female toward plant noted.

SUBSPECIES	FOODPLANT	LOCALITY	OBSERVATION
<i>shasta</i>	<i>Astragalus purshii</i> Dougl.	Ebbetts Pass, Alpine Co., Calif.	O, L
	<i>Astragalus whitneyi</i> Gray	Donner Pass, Placer Co., Calif.	O, L
	<i>Lupinus arbustus</i> Dougl. (see text)	Donner Pass, Placer Co., Calif.	L
	<i>Lupinus breweri</i> Gray	Bodie Hill, Mono Co., Calif.	P
	var. <i>bryoides</i> C.P. Sm. in Jeps.		
	<i>Lupinus lyallii</i> Gray	Tioga Pass, Mono-Tuolumne Cos., Calif.	O
	<i>Astragalus calycosus</i> Torr.	Toquima Range, Nye Co., Nevada	O
minnehaha & Great Basin populations	<i>Astragalus calycosus</i> Torr.	East Humboldt Range, Elko Co., Nevada	O
	var. <i>mancus</i> (Rydb.) Barneby		
	<i>Astragalus kentrophyta</i> Gray	Wasatch Plateau, Sanpete Co., Utah	P
	var. <i>elatus</i> Wats.		
	<i>Astragalus kentrophyta</i> Gray	White Mts., Inyo-Mono Cos., Calif.	O, P
	var. <i>implexus</i> (Canby) Barneby		
	<i>Astragalus newberryi</i> Torr.	Santa Rosa Range, Humboldt Co., Nevada	P
	<i>Astragalus platytropis</i> Gray	Toiyabe Range, Lander Co., Nevada	O
	<i>Astragalus purshii</i> Dougl.	Warner Mts., Modoc Co., Calif.	P
	<i>Oxytropis parryi</i> A. Gray	Snake Range, White Pine Co., Nevada	O
	<i>Trifolium gymnocarpum</i> Nutt.	Snake Range, White Pine Co., Nevada	O
	<i>Trifolium monoense</i> Greene	White Mts., Inyo-Mono Cos., Calif.	O
<i>pitkinensis</i>	<i>Trifolium dasyphyllum</i> T. & G.	Baldy Peak and Hermit Pass, Custer Co., Colorado	O